

Claims:

1. A magnetic anomaly sensing system, comprising:  
2       a plurality of triaxial magnetometer (TM) sensors with  
3       each of said TM sensors having X,Y,Z magnetic sensing axes,  
4       said plurality of said TM sensors arranged in a three-  
5       dimensional array with respective ones of said X,Y,Z  
6       magnetic sensing axes being mutually parallel to one another  
7       in said three-dimensional array;  
8       said three-dimensional array defining a geometry that  
9       (i) collinearly aligns at least three of said plurality of  
10      TM sensors in a spaced-apart fashion along an axis to form a  
11      plurality of single-axis gradiometers along one of said  
12      X,Y,Z magnetic sensing axes, and (ii) positions at least  
13      four of said plurality of TM sensors in a spaced-apart  
14      fashion in a planar array that is perpendicular to said  
15      axis; and  
16      processing means coupled to each of said plurality of  
17      TM sensors for generating  
18       (i) partial gradient contractions for each of said  
19       single-axis gradiometers, and  
20       (ii) partial gradient contractions, and complete  
21       gradient tensors and corresponding complete gradient  
22       contractions for gradiometers formed by said planar array,  
23       in order to provide data that can be used to

24 (a) align said axis of said three-dimensional array  
25 with a magnetic target, and

26 (b) once said axis is aligned with said magnetic  
27 target, uniquely determine (i) distance to said magnetic  
28 target, (ii) position of said magnetic target relative to  
29 said three-dimensional array, and (iii) a magnetic dipole  
30 moment of said magnetic target.

1       2. A magnetic anomaly sensing system as in claim 1 wherein  
2       three TM sensors from said plurality of TM sensors are  
3       collinearly aligned along said axis and are evenly spaced  
4       therealong, wherein a central one of said three TM sensors  
5       is centrally positioned between a remaining two of said  
6       three TM sensors.

1       3. A magnetic anomaly sensing system as in claim 2 wherein  
2       said planar array includes said central one of said three TM  
3       sensors.

1       4. A magnetic anomaly sensing system as in claim 3 wherein  
2       said planar array forms a square having one of said  
3       plurality of said TM sensors at each corner thereof

5. A magnetic anomaly sensing system as in claim 4 wherein

2       said central one of said three TM sensors lies at a center  
3       of said square.

1       6. A magnetic anomaly sensing system as in claim 2 wherein  
2       said planar array forms a square having one of said  
3       plurality of said TM sensors at each corner thereof.

1       7. A magnetic anomaly sensing system as in claim 6 wherein  
2       said axis passes through a center of said square.

1       8. A magnetic anomaly sensing system as in claim 7 wherein  
2       said planar array is positioned between said central one of  
3       said three TM sensors and one of said remaining two of said  
4       three TM sensors, said system further comprising a second  
5       planar array defined by at least four of said plurality of  
6       TM sensors with said second planar array being perpendicular  
7       to said axis and positioned between said central one of said  
8       three TM sensors and the other of said remaining two of said  
9       three TM sensors.

1       9. A magnetic anomaly sensing system as in claim 8 wherein  
2       said planar array and said second planar array are mirror  
3       images of one another relative to said central one of said  
4       three TM sensors.

1       10. A magnetic anomaly sensing system as in claim 3 wherein  
2       said planar array forms a polygon having one of said  
3       plurality of said TM sensors at each vertex thereof, said  
4       polygon having opposing sides that are of equal length and  
5       parallel to one another.

1       11. A magnetic anomaly sensing system as in claim 10  
2       wherein said central one of said three TM sensors lies at a  
3       geometric center of said polygon.

1           12. A magnetic anomaly sensing system, comprising:

2               a plurality of triaxial magnetometer (TM) sensors with

3               each of said TM sensors having X,Y,Z magnetic sensing axes,

4               said plurality of said TM sensors arranged in a three-

5               dimensional array with respective ones of said X,Y,Z

6               magnetic sensing axes being mutually parallel to one another

7               in said three-dimensional array;

8               said three-dimensional array defining a geometry that

9               (i) collinearly aligns at least three of said plurality of

10              TM sensors in a spaced-apart fashion along an axis to form a

11              plurality of single-axis gradiometers along one of said

12              X,Y,Z magnetic sensing axes, and (ii) positions at least

13              four of said plurality of TM sensors in a spaced-apart

14              fashion in a planar array that is perpendicular to said

15              axis, said planar array defining pairs of single-axis

16              gradiometers wherein each of said pairs is symmetrically

17              disposed about said axis; and

18               processing means coupled to each of said plurality of

19              TM sensors for generating

20               (i) partial gradient contractions for each of said

21              single-axis gradiometers, and

22               (ii) complete gradient tensors and corresponding

23              complete gradient contractions for multi-axis gradiometers

24              formed by said planar array,

25       in order to provide data that can be used to

26               (a) align said axis of said three-dimensional array  
27               with a magnetic target, and

28               (b) once said axis is aligned with said magnetic  
29               target, uniquely determine (i) distance to said magnetic  
30               target, (ii) position of said magnetic target relative to  
31               said three-dimensional array, and (iii) a magnetic dipole  
32               moment of said magnetic target.

1       13. A magnetic anomaly sensing system as in claim 12  
2       wherein three TM sensors from said plurality of TM sensors  
3       are collinearly aligned along said axis and are evenly  
4       spaced therealong, wherein a central one of said three TM  
5       sensors is centrally positioned between a remaining two of  
6       said three TM sensors.

1       14. A magnetic anomaly sensing system as in claim 13  
2       wherein said planar array includes said central one of said  
3       three TM sensors.

1       15. A magnetic anomaly sensing system as in claim 14  
2       wherein said planar array forms a square having one of said  
3       plurality of said TM sensors at each corner thereof.

1       16. A magnetic anomaly sensing system as in claim 15  
2       wherein said central one of said three TM sensors lies at a  
3       center of said square.

1       17. A magnetic anomaly sensing system as in claim 13  
2       wherein said planar array forms a square having one of said  
3       plurality of said TM sensors at each corner thereof.

1       18. A magnetic anomaly sensing system as in claim 17  
2       wherein said axis passes through a center of said square.

1       19. A magnetic anomaly sensing system as in claim 18  
2       wherein said planar array is positioned between said central  
3       one of said three TM sensors and one of said remaining two  
4       of said three TM sensors, said system further comprising a  
5       second planar array defined by at least four of said  
6       plurality of TM sensors with said second planar array being  
7       perpendicular to said axis and positioned between said  
8       central one of said three TM sensors and the other of said  
9       remaining two of said three TM sensors.

1       20. A magnetic anomaly sensing system as in claim 19  
2       wherein said planar array and said second planar array are  
3       mirror images of one another relative to said central one of  
4       said three TM sensors.

1       21. A magnetic anomaly sensing system as in claim 14  
2       wherein said planar array forms a polygon having one of said  
3       plurality of said TM sensors at each vertex thereof, said  
4       polygon having opposing sides that are of equal length and  
5       parallel to one another.

1       22. A magnetic anomaly sensing system as in claim 21  
2       wherein said central one of said three TM sensors lies at a  
3       geometric center of said polygon.